

Chapter 1 MP Systems

The MP System is a computer-based data acquisition system that performs many of the same functions as a chart recorder or other data viewing device, but is superior to such devices in that it transcends the physical limits commonly encountered (such as paper width or speed). The MP data acquisition unit (MP150 or MP100) is the heart of the MP System. The MP unit takes incoming signals and converts them into digital signals that can be processed with your computer.

MP Systems can be used for a wide array of applications, including:

Cardiovascular Hemodynamics	Evoked Response	Plethysmography
ECG: Cardiology	Exercise Physiology	Psychophysiology
EEG: Electroencephalogram	Interfacing with Existing Equipment	Pulmonary Function
EMG: Electromyogram	<i>In vitro</i> Pharmacology	Remote Monitoring
EOG / Eye Movement	Laser Doppler	Sleep Studies

Data collection generally involves taking incoming signals (usually analog) and sending them to the computer, where they are (a) displayed on the screen and (b) stored in the computer's memory (or on the hard disk). These signals can then be stored for future examination, much as a word processor stores a document or a statistics program saves a data file. Graphical and numerical representations of the data can also be produced for use with other programs.

- ❖ Application Notes are provided at www.biopac.com under Support; see page 17.
- ❖ **Quick Start** Templates are provided in the Samples folder to simplify setup; see page 19.

The MP System can be used on a Macintosh® or on a PC with Windows®. The System utilizes the same hardware, excepting hardware for computer interface. The software has the same “look and feel” on both the Macintosh® and the PC.

MP150 STARTER SYSTEM



*MP150 Specifications are on page 12.

The **new MP150** high-speed data acquisition system utilizes the very latest in Ethernet technology. The MP150 is compliant with any Ethernet (DLC) ready PC or Macintosh. This next generation product takes full advantage of cutting edge technology. Access multiple MP150 devices located on a local area network and record data to any computer connected to the same LAN. Record multiple channels with variable sample rates to maximize storage efficiency. Record at speeds up to 400kHz (aggregate).

MP150 System includes:

- Data acquisition unit: MP150A-CE
- Universal interface module: UIM100C
- Ethernet Switch (for user-supplied Ethernet card or adapter): ETHSW1
- Transformer: AC150A
- Cables: CBLETH1 (2)
- AcqKnowledge® software: ACKv3.7 for PC (Windows)
ACKv3.5 for Macintosh

Recommended MP150 configuration:

For the best possible performance, connect the MP System solely to the computer's Ethernet port. For simultaneous connection of the network and the MP System, the ETHSW1 is required. If a computer has no Ethernet port, users need to install an industry standard PCI Ethernet card (Intel, 3COM, etc.). If a computer does not require simultaneous connection to the network, it's acceptable to use a standard crossover Ethernet cable to connect the MP System to a computer.

MP150 Symbology



Front panel		The front panel of the MP150 has three status indicators.	
LED Label	Color	Indicates	Status
POWER	green	Power status	Bright (on) if MP150 is turned ON. Dark (off) if MP150 is turned OFF.
ACTIVITY	yellow	Traffic to or from MP150 for both Ethernet and Serial interface — <i>similar to Hard Disk activity light on any personal computer</i>	Blinks if data/command traffic occurs on Ethernet or Serial interface. The frequency of blinks is proportional to amount of traffic to/from MP150. May blink randomly if traffic is low. Bright (on) if traffic is extremely high. Dark (off) if traffic is low.

LED Label	Color	Indicates	Status
BUSY	green	MP150 acquisition	<p>Bright (on) during acquisition</p> <p>Dark (off) if no traffic to/from MP150</p> <p>Blinks for some errors.</p> <p>In averaging mode, the busy light will light up during each trial.</p>

MP150 Work Mode LED Indicators

Startup phase
When MP150 is turned ON, ACTIVITY and BUSY will shine for the duration of the self-test and setup process. This may take 3 – 10 seconds, depending on MP150 memory. After this, if MP150 is OK, ACTIVITY and BUSY will go dark for about 1 second before proceeding to the idle phase.
If the self-test fails or setup fails, BUSY will remain bright and ACTIVITY will blink at about 5 Hz rate.

Idle phase
The idle phase is time when MP150 does not receive any commands/requests from Ethernet or Serial connector.
In Idle, BUSY is off and ACTIVITY blinks from time to time (approx. 1 – 5 second interval). ACTIVITY blinks because the MP150 is checking the network connection. Also, it may receive test signals from another MP150 or from another workstation in the LAN.
If MP150 is not connected to LAN or all other workstations are turned off, MP150 will not receive any responses from Ethernet. In this case (after three attempts) ACTIVITY and BUSY will alternate blinks. In most cases this means ‘MP150 not connected to LAN.’ In rare cases, it may mean ‘Another MP150 with the same serial number exists in the LAN.’

Working mode

no data acquisition
If running *AcqKnowledge* software and not collecting data, BUSY is off and ACTIVITY reflects data traffic between the MP150 and PC.
When running through the Ethernet, ACTIVITY will blink infrequently. When running through the Serial Interface (not typical connection), ACTIVITY will blink frequently because the software continuously checks MP150 status.

data acquisition
BUSY will be bright during any acquisition. ACTIVITY reflects data traffic (for acquisition speeds of 1000 Hz or more, ACTIVITY will be permanently bright or blink at a high frequency).

AcqKnowledge software closed
In this case, the MP150 falls into Idle mode. This occurs immediately under *AcqKnowledge* Ethernet Interface but under *AcqKnowledge* Serial Interface there will be a 25 - 30 second delay.

Back panel

Power switch
On powers up the MP150
Off cuts the flow of power to the MP150

Fuse holder
Next to the power switch is a 2 Amp fast-blow fuse holder.
To remove the fuse, use a screwdriver to remove the fuse cover, which is located below the word **Fuse**.
The maximum capacity of the fuse is 2 Amps.

Back panel

cont'd

DC Input

The **DC Input**, located between the fuse holder and the serial cable, is where a battery, AC/DC converter or other power supply connects to the MP150. The power supply requirements for the MP150 are 12 VDC @ 2 Amps, The receptacle is configured to accept a “+” (positive) input in the center of the connector and a “-” (negative) input on the connector housing.

Serial port

The MP150 connects to the computer via a serial port, located just below the word **Serial** (this connection is not normally used).

Uses a standard MINI DIN 8 connector.

Should only be used to connect the MP150 to a PC (via USB1M or USB1W) or Macintosh.

Ethernet

The MP150 connects to the computer via a serial port, located just below the word **Ethernet**.

Uses a standard RJ-Ethernet connector (10 base T)

Side panel

Module connections

The two connector inputs are designed to connect directly to the UIM100C.

Analog signals are transmitted through the 37-pin connector that is on the upper-right side of the MP150A unit.

Digital signals are transmitted through the 25-pin connector that is on the lower-right side of the MP150A unit.

Bottom

Firmware Rollback Switch

The Firmware Rollback Switch is located on the bottom of the MP150 unit and is recessed to prevent accidental activation.

Use the Firmware Rollback Switch only under the following circumstances:

- A) The MP150 fails to operate after downloading a new firmware revision using the “MP150Tools.exe” utility (which is described in **Appendix F** of the *MP Systems Guide*).
- B) The MP150 fails to operate for other reasons.

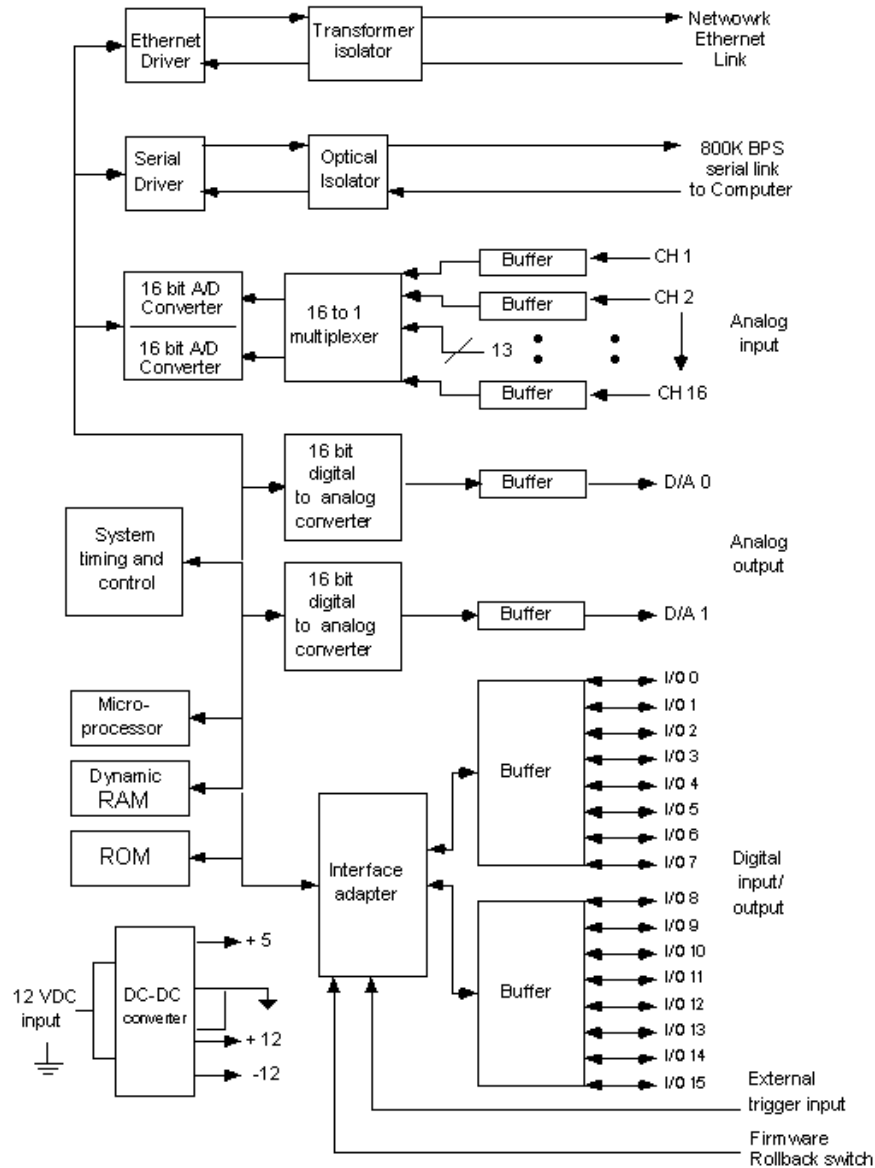
Activation of the Firmware Rollback Switch will cause the MP150 unit to operate under the previous version of firmware loaded into the unit. If the MP150 has only been loaded with one version of the firmware (as when originally shipped from the factory), the Firmware Rollback Switch will have no effect.

Procedure:

- 1) Turn the MP150 unit OFF.
- 2) Turn the MP150 unit upside down and use a small-tipped device (an unfolded paperclip will do) to depress and hold the switch down.
- 3) Continue to hold the switch down, and turn the MP150 unit ON.
 - * One green and one yellow LED light will begin to blink simultaneously.
- 4) When the simultaneous blinking stops, release the switch.
 - * The MP150 is now restored to the previous version of firmware.
 - * You can check the firmware version via the “MP150>About MP150” menu item in *AcqKnowledge*.

MP150A-CE Data Acquisition Unit Block Diagram

The MP150 has an internal microprocessor to control the data acquisition and communication with the computer. There are 16 analog input channels, two analog output channels, 16 digital channels that can be used for either input or output, and an external trigger input. The digital lines can be programmed as either inputs or outputs and function in 8 channel blocks. Block 1 (I/O lines 0 through 7) can be programmed as either all inputs or all outputs, independently of block 2 (I/O lines 8 through 15).



MP150A-CE block diagram

*MP150 Specifications are on page 12.

Chapter 2 Interface Modules

UIM100C Universal Interface Module



HLT100C

UIM100C

The UIM100C Universal Interface Module is the interface between the MP150/100 and external devices. Typically, the UIM100C is used to input pre-amplified signals (usually greater than ± 0.1 volt peak-peak) and/or digital signals to the MP150/100 acquisition unit. Other signals (e.g., those from electrodes or transducers) connect to various signal-conditioning modules.

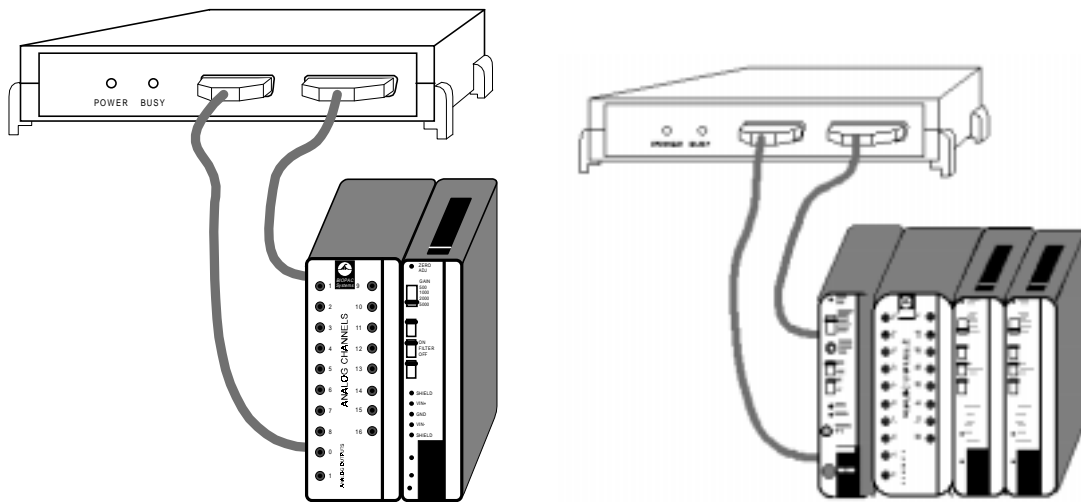
The Universal Interface Module (UIM100C) is designed to serve as a general-purpose interface to most types of laboratory equipment. The UIM100C consists of sixteen 3.5 mm mini-phone jack connectors for analog inputs, two 3.5 mm mini-phone jack connectors for analog outputs, and screw terminals for the 16 digital lines, external trigger, and supply voltages.

The UIM100C is typically used alone to connect polygraph and chart recorder analog outputs to the MP System. BIOPAC Systems, Inc. offers a series of cables that permit the UIM100C to connect directly to a number of standard analog signal connectors. Most chart recorders or polygraphs have analog signal outputs, which can be connected directly to the UIM100C.

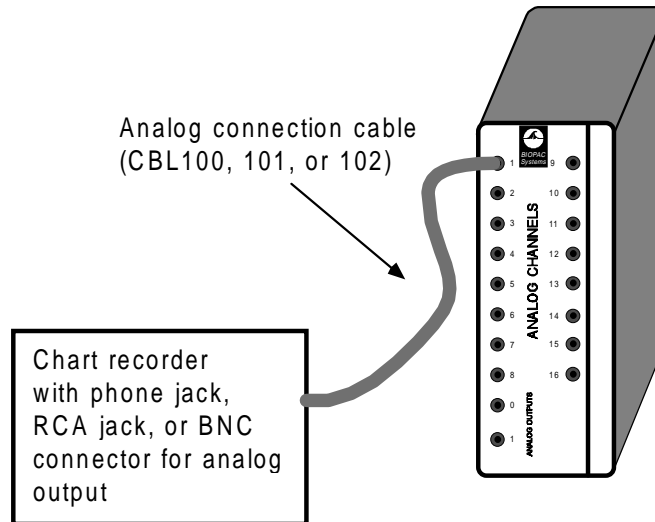
The UIM100C allows access to 16 analog inputs and 2 analog outputs on one side, and 16 digital input/output lines, an external trigger, and supply voltages on the other side. The UIM100C is designed to be compatible with a variety of different input devices, including the BIOPAC series of signal conditioning amplifiers (such as the ECG100C).

Connections between the UIM100C and the MP150/100 acquisition unit are made via two cables: one for analog signals (with a 37-pin connector) and one for digital signals (with a 25-pin connector). Use the 0.6-meter cables included with your system to connect the UIM100C to the acquisition unit.

When using the Universal Interface Module (UIM100C) with other 100-Series modules, the UIM100C is usually the first module cascaded in the chain. If using the STM100C, OXY100C or HLT100C, the module must be plugged in on the **left** of the UIM100C. Up to seventeen modules (including the UIM100C) can be snapped together, as illustrated in the following diagrams:



MP100 to UIM100C and amplifier module STM100C and UIM100C and amplifier modules



Typical UIM100C to polygraph interface

When using the UIM100C, be careful not to short the “analog output” terminals together, and not to short across any of the connectors on the “Digital” (back) side of the module.

IMPORTANT USAGE NOTE

Mains powered external laboratory equipment should be connected to an MP System through signal isolators when the system also connects to electrodes attached to humans.

To couple external equipment to an MP System, use:

- ❖ For **analog** signals — **INISO** or **OUTISO** isolator (with **HLT100C**)
- ❖ For **digital** signals — **STP100** (with **UIM100C**)

Contact BIOPAC for details.

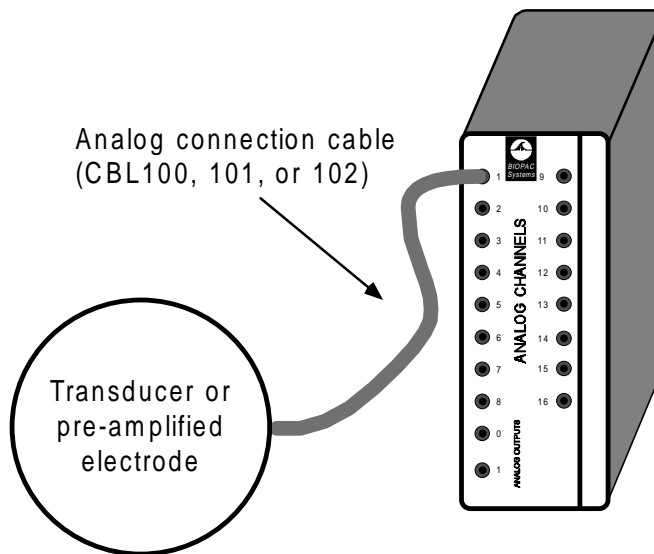
Analog connections



As noted, the UIM100C requires cables equipped with standard 3.5mm mini-phone plugs to connect to analog signal sources. This type of connector is commonly available with many different mating ends. BIOPAC Systems, Inc. carries several different types, including BNC and phone plugs. Since the MP150/100 analog inputs are single-ended, the tip of the mini-phone plug is the input and the base (shield) of the mini-phone plug is the ground (or common).

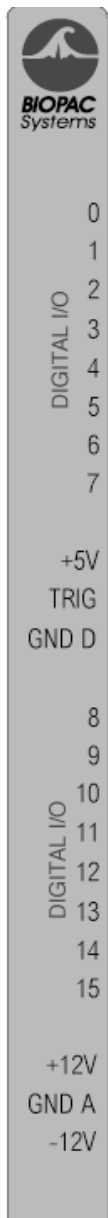
NOTE: Make sure the cable that you route into the UIM100C is a **mono** 3.5 mm phone plug.

To connect to existing equipment (such as polygraphs or chart recorders), run a cable from the analog output terminal of the external device to the UIM100C. Since there are so many different devices that can connect to the MP150/100 it's impossible to cover them all.



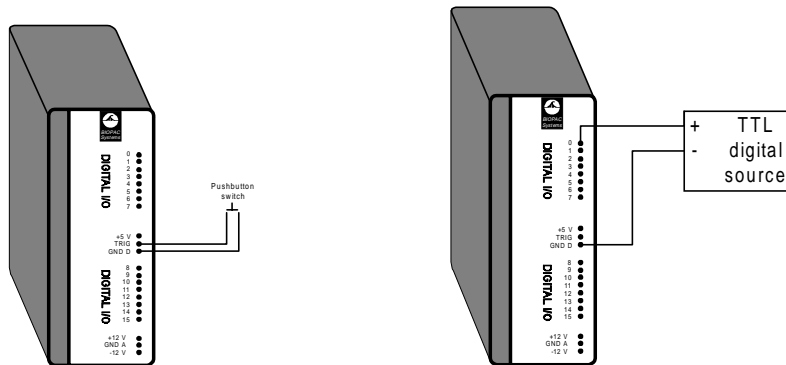
UIM100C connected to external analog signal source

Please contact a BIOPAC Systems, Inc. applications engineer if you are not sure how to connect the MP System to your device or if you need a special cable.



Digital connections

A digital signal has only two voltage levels: 0 and +5 volts. Zero volts is a binary “0” and +5 volts is a binary “1.” A **positive edge** is a 0 to 1 transition and a **negative edge** is a 1 to 0 transition. The MP150/100 digital I/O lines have internal pull-up resistors so that unconnected inputs will read “1.”

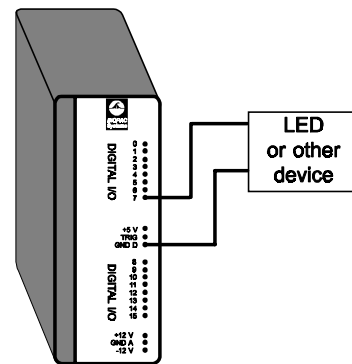


Trigger connected to UIM100C MP unit to digital source connection

The UIM100C allows access to 16 digital input/output lines through screw terminals which can accept either pin plugs or bare wires, as shown above. Be careful not to short the +5, +12V and –12V terminals together or to the GND A or GND D output terminal, or you may damage the MP150/100.

The 16 digital lines are divided into two blocks, I/O 0 through 7 and I/O 8 through 15. Each of these blocks can be programmed as either inputs or outputs. Do not connect a digital input source to a block that is programmed as an output.

It is also possible to connect an output device (such as an LED) to the digital side of the UIM100C. LEDs and similar devices can be connected so that they are “on” either when a signal output from the UIM100C reads 0 Volts or when a +5 Volt signal is being output. To connect an LED so that it defaults to “off” (i.e., the digital I/O reads 0), attach one lead of the output device to the GND D terminal on the UIM100C and connect the other lead to one of the digital I/O lines (I/O 7, for example). When configured this way, the device will be “off” when I/O 7 reads 0, and “on” when I/O 7 reads a digital “1” (i.e., +5 Volts). When connecting to an LED, be sure to use a current-limiting resistor (typically 330Ω) in series with the LED. Alternatively, you can connect one of the device leads to the +5V terminal on the UIM100C and leave the other lead connected to the digital line (e.g., I/O 7). With this setup, the device will be on whenever the I/O line (in this case digital I/O 7) reads 0, and on whenever the I/O reads a digital “1” (i.e., +5 Volts)

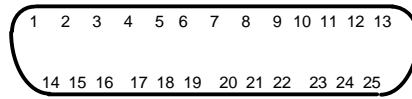


UIM100C Specifications

Analog I/O:	16 channels (front panel) – 3.5mm phone jacks
D/A Outputs:	2 channels (front panel) – 3.5mm phone jacks
Digital I/O:	16 channels (back panel) – screw terminals
External Trigger:	1 channel (back panel) – screw terminal
Isolated Power:	±12V, +5V @ 100 ma (back panel) – screw terminals
Weight:	520 grams
Dimensions:	7cm (wide) x 11cm (deep) x 19cm (high)

MP System Pin-outs — for MP150 and MP100

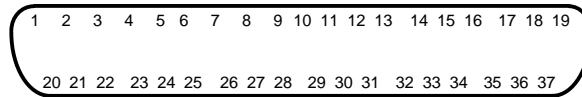
Digital DSUB 25 (male) Pin-outs



DIGITAL

Pin	Description	Pin	Description
1	I/O 0	14	I/O 4
2	I/O 1	15	I/O 5
3	I/O 2	16	I/O 6
4	I/O 3	17	I/O 7
5	GND D	18	GND A
6	GND D	19	Out 1
7	EXT T	20	Out 0
8	+5 VD	21	GND A
9	+5 VD	22	I/O 12
10	I/O 8	23	I/O 13
11	I/O 9	24	I/O 14
12	I/O 10	25	I/O 15
13	I/O 11		

Analog DSUB 37 (male) Pin-outs



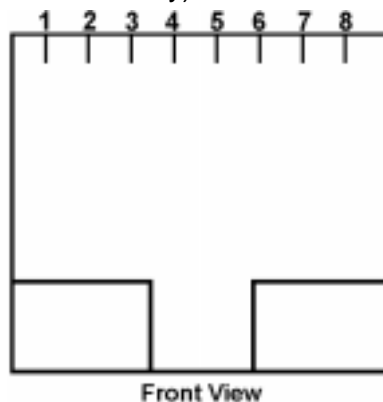
ANALOG

Pin	Description	Pin	Description
1	GND A	20	CH 1
2	GND A	21	CH 2
3	GND A	22	CH 3
4	GND A	23	CH 4
5	GND A	24	CH 5
6	GND A	25	CH 6
7	GND A	26	CH 7
8	GND A	27	CH 8
9	+12 V	28	+12 V
10	GND A	29	- 12 V
11	-12 V	30	CH 9
12	GND A	31	CH 10
13	GND A	32	CH 11
14	GND A	33	CH 12
15	GND A	34	CH 13
16	GND A	35	CH 14
17	GND A	36	CH 15
18	GND A	37	CH 16
19	GND A		

Serial MINI DIN 8 (female) Pin-outs

Pin	Description
1	No Connection
2	Clock (MP Output)
3	Rx+ (MP Input)
4	GND computer
5	Tx+ (MP Output)
6	Rx- (MP Input)
7	No Connection
8	Tx- (MP Output)

Ethernet connector Pin-outs (for model MP150 only)



Front View

Pin	Description
1	TXD+
2	TXD-
3	RXD+
4	No Connection
5	No Connection
6	RXD-
7	No Connection
8	No Connection

MP System Applications

Features

With proper hardware selection and setup, the MP System with AcqKnowledge software can be used for a wide array of application features. See the MP System Guide for descriptions of the following features. For additional support, or for help with an unlisted application, please contact the BIOPAC Technical Support Division — an Applications Specialist will be glad to help you.

Active Electrodes	Gait Analysis	Planted Tissue
Allergies	Gastric Myoelectric Activity	Pressure Volume Loops
Amplitude Histogram	Gastric Slow Wave Propagation	Psychophysiology
Anaerobic Threshold	Gastrointestinal Motility Analysis	Pulsatile Tissue Studies
Animal studies	Hardware Flexibility	Pulse Rate Measurement
Auditory Evoked Response (AER)	Heart Rate Variability	Pulse Transit Time
Automate Acquisition Protocols	Heart Sounds	Range of Motion
Automated Data Analysis	Histogram Analysis	Real-time EEG Filtering
Automatic Data Reduction	Imaging Equipment, Interfacing	Real-time EEG Filtering
Autonomic Nervous System Studies	Indirect Blood Pressure Recordings	Recurrent Patterns
Biomechanics Measurements	Integrated (RMS) EMG	Regional Blood Flow
Blood Flow / Blood Pressure /Blood Volume	Interface with Existing Equipment	Relative BP Measurement
Body Composition Analysis	Interface with Third-party transducer	Remote Monitoring
Breath-By-Breath Respiratory Gas Analysis	Invasive Electrode Measurements	Respiration Monitoring
Cardiac Output	Ion-selective Micro-electrode Interfacing	Respiratory Exchange Ratio
Cardiology Research	Iontophoresis	Rheumatology
Cell Transport	Irritants & Inflammation	Saccadic Eye Movements
Cerebral Blood Flow	Isolated Inputs & Outputs	Sexual Arousal Studies
Chaos Plots	Isolated Lung Studies	Signal Averaging
Common Interface Connections	Isometric Contraction	Simultaneous Monitoring
Connect to MP Systems	Isotonic Contraction	Single Channel Analysis
Control Pumps and Valves	Jewett Sequence	Single-fiber EMG
Cross- and Auto-correlation	Langendorff Heart Preparations	Software-controlled Stimulator
Current Clamping	Laser Doppler Flowmetry	Somatosensory Evoked Response
Defibrillation & Electrocautery	Left Cardiac Work	Spectral Analysis
Dividing EEG into Specific Epochs	Long-term Monitoring	Spike Counting
ECG Analysis	Lung Volume Measurement	SpO2 Analysis
ECG Recordings, 12-Lead	LVP	Stand Alone Amplifiers
ECG Recordings, 6-Lead	Median & Mean Frequency Analysis	Standard Operating Procedures
EEG Spectral Analysis	Micro-electrode signal amplification	Startle Eye Blink Tests
Einthoven's Triangle	Migrating Myoelectric Complex	Startle Response
EMG and Force	Motor Unit Action Potential	Stimulator, software-controlled
EMG Power Spectrum Analysis	Movement Analysis	Systemic Vascular Resistance
End-tidal CO2	MRI Applications	Template Analysis
Episode Counting	Multi-Channel Sleep Recording	Tissue Bath Monitoring
Ergonomics Evaluation	Nerve Conduction Studies	Tissue Conductance Measurement
Event-related Potentials	Neurology Research	Tissue Magnitude & Phase Modeling
Evoked Response	Noninvasive Cardiac Output	Tissue Resistance & Reactance
Exercise Physiology	Noninvasive Electrode Measurements	Ussing Chamber Measurements
External equipment, controlling	Nystagmus Investigation	Ventricular Late Potentials
Extra-cellular Spike Recording	Oculomotor Research	Vestibular Function
Facial EMG	Off-line ECG Averaging	Video Capture, Synchronous
FFT & Histograms	On-line Analysis	Visual Attention
FFT for Frequency Analysis	On-line ECG Analysis	Visual Evoked Response
Field Potential Measurements	Orthostatic Testing	VO2 Consumption
Fine Wire EMG	Peripheral Blood Flow	Volume/Flow Loop Relationships
Forced Expiratory Flow & Volume	Peristaltic (Slow Wave) Propagation	Working Heart Preparations

Application Notes

BIOPAC has prepared a wide variety of application notes as a useful source of information concerning certain operations and procedures. The notes are static pages that provide detailed technical information about either a product or application. A partial list of Application Notes follows.

You can view or print application notes directly from the “Support” section of the BIOPAC web site www.biopac.com.

APP NOTE	Application
#AH101	Transducer Calibration and Signal Re-Scaling
#AH102	Biopotential Amplifier Testing using CBLCAL
#AH103	Remote Monitoring System (TEL100C)
#AS105	Auditory Brainstem Response (ABR) Testing
#AS105b	ABR Testing for Jewett Sequence
#AS108	Data Reduction of Large Files
#AS109	3-, 6-, and 12-Lead ECG
#AH110	Amplifier Baseline (Offset) Adjustment
#AS111	Nerve Conduction Velocity
#AH114	TSD107A Pneumotach Transducer
#AH114b	TSD107B Pneumotach Transducer
#AS115	Hemodynamic Measurements — Part I
#AS116	Hemodynamic Measurements — Part II
#AS117	Pulse Transit Time and Velocity Calculation
#AS118	EMG Signal Analysis
#AS119	EMG Power Spectrum Analysis
#AS120	X/Y Loop Area Analysis
#AS121	Waveform Data Reduction
#AS122	Power Spectrum Analysis
#AH125	Pulse Oximeter Module Operation
#AH127	Precision Force Transducers
#AH128	Active Electrode Specifications and Usage
#AS129	Heart Rate Variability
#AH130	Blood Pressure Measurement
#AS131	Averaging Mode
#AH132	TSD105A Variable Force Transducer
#AH135	TSD117 Pneumotach Transducer
#AH136	BAT100 Instructions
#AH140	Angular Measurements with Goniometers
#AH141	Tri-Axial Accelerometer Calibration
#AS142	AcqKnowledge Rate Detector Algorithm
#AS143	Importing AcqKnowledge Data Into Excel

APP NOTE	Application
#AH144	Hand Dynamometer Calibration
#AH145	TSD101B Respiratory Effort Transducer
#AS148	Automated ECG Analysis
#AH149	O2100C Module
#AH150	O2100C Module — Sample application
#AH151	CO2100C Module
#AH152	CO2100C Module — Sample Application
#AH153	Physiological Sounds Microphone
#AH154	HLT100C High Level Transducer
#AS158	Analysis of Inspired and Expired Lung Volume
#AH159	TSD116 Series Hand Switch and Foot Switch
#AH160	Gas Analysis Module Response Time
#AS161	Automated Tissue Bath Analysis
#AH162	Stimulation Features
#AS168	Analysis of Intraventricular Pressure Wave Data (LVP Analysis)
#AS169	Speech Motor Control
#AH170	LDF100A Laser Doppler Flow Module
#AH175	Using the STMISOC Stimulus Isolator
#AS177	ECG Analysis using the Offline Averaging Mode
#AS183	VO ₂ Measurement
#AH186	Psychological Assessment using the TSD115
#AH187	Electrodermal Response (EDR) using the GSR100 or TEL100
#AH190	Using the MCE100C Micro-electrode Amplifier
#AS191	Cardiac Output Measurement using the EBI100C and <i>AcqKnowledge</i>

AcqKnowledge **QUICKSTARTS** for PC 3.7

“Quick Start” template files were installed to the Sample folder of the BIOPAC Program folder. Use a Quick Start template to establish the hardware and software settings required for a particular application or as a good starting point for customized applications.

Q##	Application(s)	Feature
1	EEG	Real-time EEG Filtering
	Sleep Studies	Real-time EEG Filtering
2	EEG	Evoked Responses
3	EEG	Event-related Potentials
	Evoked Response	Event-related Potentials
4	Evoked Response	Nerve Conduction Studies
5	Evoked Response	Auditory Evoked response & Jewett Sequence
6	Evoked Response	Visual Evoked Response
7	Evoked Response	Somatosensory Evoked Response
9	Evoked Response	Extra-cellular Spike Recording
10	Psychophysiology	Autonomic Nervous System Studies
12	Psychophysiology	Sexual Arousal Studies
13	EBI	Cardiac Output
	Cardiovasc. Hemodynamics	Noninvasive Cardiac Output Measurement
	Exercise Physiology	Noninvasive Cardiac Output
15	EOG	Nystagmus Investigation
16	EOG	Saccadic Eye Movements
17	Plethysmography	Indirect Blood Pressure Recordings
19	Sleep Studies	Multiple-channel Sleep Recording
20	Sleep Studies	Cardiovasc. Hemodynamics
	ECG	On-line ECG Analysis
	ECG Analysis	On-line ECG Analysis
21	Sleep Studies	SpO ₂ Analysis
22	ECG	Einthoven's Triangle & 6-lead ECG
23	ECG	12-lead ECG Recordings
24	ECG	Heart Sounds
25	Cardiovasc. Hemodynamics	On-line Analysis
26	Cardiovasc. Hemodynamics	Blood Pressure
27	Cardiovasc. Hemodynamics	Blood Flow
28	Cardiovasc. Hemodynamics	LVP
31	NIBP	Psychophysiology
32	<i>In vitro</i> Pharmacology	Tissue Bath Monitoring
33	<i>In vitro</i> Pharmacology	Pulsatile Tissue Studies
34	<i>In vitro</i> Pharmacology	Langendorff & Working Heart Preparations
35	<i>In vitro</i> Pharmacology	Pulmonary Function
	Isolated Lung Studies	Animal Studies
38	Pulmonary Function	Lung Volume Measurement
39	Exercise Physiology	Respiratory Exchange Ratio
40	EMG	Integrated (RMS) EMG
41	EMG	EMG and Force
42	Biomechanics	Gait Analysis
43	Remote Monitoring	Biomechanics Measurements
44	Biomechanics	Range of Motion